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The Social Production of Financial Inclusion of Generation Z in Digital Banking Ecosystems

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Keywords

Financial inclusion, Generation Z, Social production of space, Digital banking ecosystem

Cover Page Footnote

The authors gratefully acknowledge the immense contributions of individuals and institutions that made the execution of the research possible, and those who particularly helped to bring a balance and perspective to the message in this paper



The Social Production of Financial Inclusion of Generation Z in Digital Banking Ecosystems

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Abstract

Digital finance is an emerging frontier of financial sector development in the contemporary 21st century. In spite of the known benefits of digital finance, there is a widely held view that digital financial services have not adequately permeated vast segments of society given the disparities in the availability of finance, its accessibility, and use. Therefore, the evolution of financial technologies along with digital consumer behaviourism in the present age presents scope for re-modelling conventional financial business models to particularly enhance the financial inclusion of Generation Z. This generation presumably has a unique mental construct of digital financial inclusion on account of its financial needs and circumstances, and its intrinsic digital consumer behaviourism. Therefore, this article espouses the Lefebvorean Social Production of Space as a novel theoretical lens through which financial inclusion of Generation Z could be better conceptualised to provide predictive insight for the future development of inclusive digital banking ecosystems. To this end, the article demonstrates, under the Zambian context in sub-Saharan Africa, that Generation Z has the propensity and competence to use digital technologies, but its adoptive response to digital finance is shaped by the perception that conventional banking and finance is highly exclusive. This suggests that the conventional banking ecosystem operates along a continuum between social equity and financial sustainability, posing a conceptual challenge of designing financial business models that are equitable without undermining the sustainability of the ecosystem. It is hereby recommended that for a digital banking ecosystem to be authentically inclusive of Generation Z there must be participatory accountability that considers and embraces the generation's bidding strategies for financial inclusion, and further facilitates empowerment of this clientele based on the co-evolutionary dynamics of financial technology and digital consumer behaviourism.⁴

JEL classification: D14, G21, G53

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1. INTRODUCTION

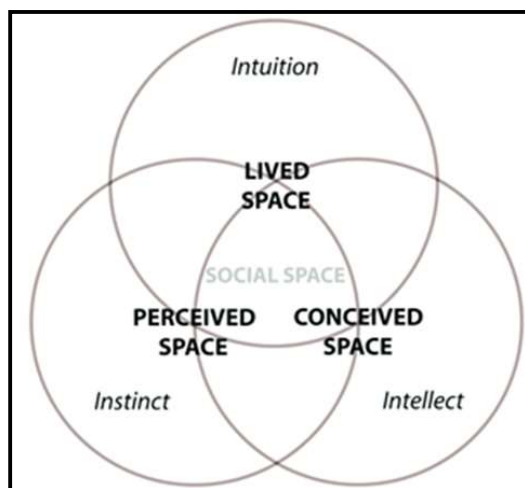
The global policy discourse on sustainable financial sector development revolves around the inclusion of the poor into the formal economy through provision of affordable financial products and services. In the digital age of human civilisation, financial inclusion is defined by the Consultative Group to Assist the Poor [CGAP] (2020) as digital access to, and the use of, formal financial services by the excluded and underserved population. In this vein, Digital Financial Services [DFS] are formally recognized as critical tools in facilitating global financial inclusion. Buckley and Malady (2014) uphold digital financial services as key financial solutions for improving financial inclusion. The United Nations (2016) acknowledges the significant role of digital financial services in contributing to poverty reduction and financial inclusion in the developing economies; and the Global Partnership for Financial Inclusion [GPFI] (2017) encourages governments to embrace digital approaches to financial inclusion and design and implement digital solutions of their own. On this global agenda for financial inclusion, the Alliance for Financial Inclusion [AFI] (2018) reports that several countries have been implementing policies and developing national financial inclusion strategies.

In view of the global developments in the financial sector towards financial inclusion of the marginalised segments of the human population, Digital finance is an emerging frontier of financial sector development in the contemporary 21st century. Digital financial services are notably associated with several benefits. Haider (2018) asserts that DFS are more convenient and affordable than traditional banking services, enabling low income and poor people in developing countries to save and borrow in the formal financial system, earn a financial return, and smooth their consumption. Consequently, three quarters of low- and lower-middle income countries in the world have DFS deployments (Harihareswara *et. al.*, 2018). DFS deployments such as mobile money platforms are increasingly seen as a source of direct revenue. In fact, DFS deployments have been reported to contribute more than \$2.4 billion in direct revenue and revenue growth of 34 % year-on-year notwithstanding that 1.7 billion adults remain unbanked worldwide (Demirgüç-Kunt *et. al.*, 2018). In light of DFS deployments, Harihareswara *et. al.* (2018) report that there was a worldwide increase in overall financial inclusion to the extent that 69 % of the adult population had access to an account at a financial institution or a mobile money provider, compared to 62% in 2014; and that globally, 52% of adults made or received payments digitally at least once in the past 12 months in 2017, compared to 41% in 2014. In sub-Saharan Africa, 34% of the adult population made or received payments digitally in 2017, compared to 27% in 2014 (Harihareswara *et. al.*, 2018).

In spite of the known benefits of digital finance, digital financial services are still widely held out as not having adequately permeated vast segments of society given that there are disparities in the availability of finance, its accessibility and use (Ozili, 2018). To this end, financial inclusion remains a distinctive pervasive gap in digital finance that deserves attention in the science and policy discourses. In the context of sub-Saharan Africa, Demirgüç-Kunt and Leora Klapper (2012) observed that despite the financial sector growth in Africa over the past decades, many individuals and firms were still excluded from access to financial services. In the wake of the sustainable development paradigm seeking to leave no one behind, financial inclusion is increasingly receiving greater attention. Since 2010, the G-20 and the World Bank have led the initiative for increased financial inclusion in developing countries to help reduce poverty levels (GPFI, 2010). To this

effect, the evolution of Financial technologies along with the emergence of Generation Z as a rising new demographic of tech savvy users is seen to present a scope for improving financial inclusion within the digital banking ecosystem. Francis and Hoefel (2018) identify Generation Z to be an interesting generational cohort that accounts for 32% of the world population, and is characterised by people born from 1995 to 2010 that are shaped by the digital age, which has exposed them to the Internet, social networks, and mobile systems thereby producing a hyper-cognitive generation that is very comfortable with collecting and cross-referencing many sources of information and with integrating virtual and offline experiences. While the introduction of financial technologies is increasingly seen to be a key driver of digital financial services, Mas and Porteous (2014) argue that transitioning towards digital financial inclusion requires that digital financial services be more aware of people's circumstances and needs.

This paper espouses the Lefebvorean Social Production of Space as a novel theoretical lens through which digital financial inclusion of Generation Z in digital banking ecosystems could be better conceptualised. In his philosophical view of the concept of "Space", Lefebvre (1991) postulates the idea that humans produce social relations that are bounded, related and organized in social spaces. Fuchs (2019) elaborated on the main ideas in this theory to exposit that *social space* is a bounded combination of social relations, structures, practices, social systems, and institutions that exist in a dialectical condition; and as such, humans produce and reproduce social structures that enable and constrain the practices in social systems. Fuchs (2019) further exposits the Lefebvorean tripartite production of social space, highlighting that all social life is a unity of mentally perceiving the physical and social world (*perceived space*); mentally conceiving this world in particular cognitive ways as thoughts (*conceived space*); and living the world in social relations in which humans communicatively produce themselves, use-values, collective decisions, rules, morals, norms, collective meanings, etc. (*Lived space*). This Lefebvorean conceptual triad of social space is well-illustrated graphically in Figure 1 by Wiedmann & Salama (2012).



Source: (Wiedmann & Salama, 2012)

Figure 1: The Lefebvorean conceptual triad of social space

In the conceptual triad of social space, Lefebvre theorises that *Perceived space* is the first dimension in the production of social space, and the practical basis of the perception of the physical and social world. Lefebvre presents this as the society's "spatial practice" that is instinctively

revealed through deciphering of space, and is logically conceived in the realm of neo-capitalism. Thus, conceptualisation of spatial practice occurs in the *Conceived space*. This space represents the principles, beliefs and visions of scientists, planners, urbanists, technocratic sub-dividers and social engineers, as of a certain type of artist with a scientific bent- all of whom identify what is lived and what is perceived with what is conceived (Lefebvre, 1991). Lefebvre posits that this space is derived from accumulated scientific knowledge that is disseminated with an admixture of ideology. This representation of space has epistemological elements of science and ideology that are founded upon the ideals of intellectualism, and hence having a dominating effect on the users of the objects created in the conceived space. Upon this proposition, Lefebvre (1991) concludes that the producers of space always act in accordance with a representation, while the “Users and inhabitants” intuitively experience whatever is imposed upon them in as much as it is more or less thoroughly inserted into, or justified by their representational space so referred to as the *Lived space*. Giesecking *et.al.* (2014) contemplate upon the Lefebvrian theory of Social Production of Space, and insightfully reveal that the socially produced space is perpetuated and reproduced in place and time through administrative policies, social conventions, and technological systems for living. This revelation provides a conceptual basis for exploring how financial inclusion is socially produced in the evolving financial socio-technical system created by digital technology and consumer behaviourism.

Under the problem context of exclusive financial sector development for which there is limited understanding of the intrinsic evolutionary dynamics, this research conceptualises digital financial inclusion as a product of a nexus of interactive processes of perception, digital consumer behaviourism, and the mental construct of digital financial inclusion that respectively determine the utility (x) and usability (y) of, as well as the adoptive response (z) to the financial services within the digital banking ecosystem (See Figure 2). The verifiable indicator of digital financial inclusion is then the bidding strategy of Generation Z for participation in the digital banking ecosystem.

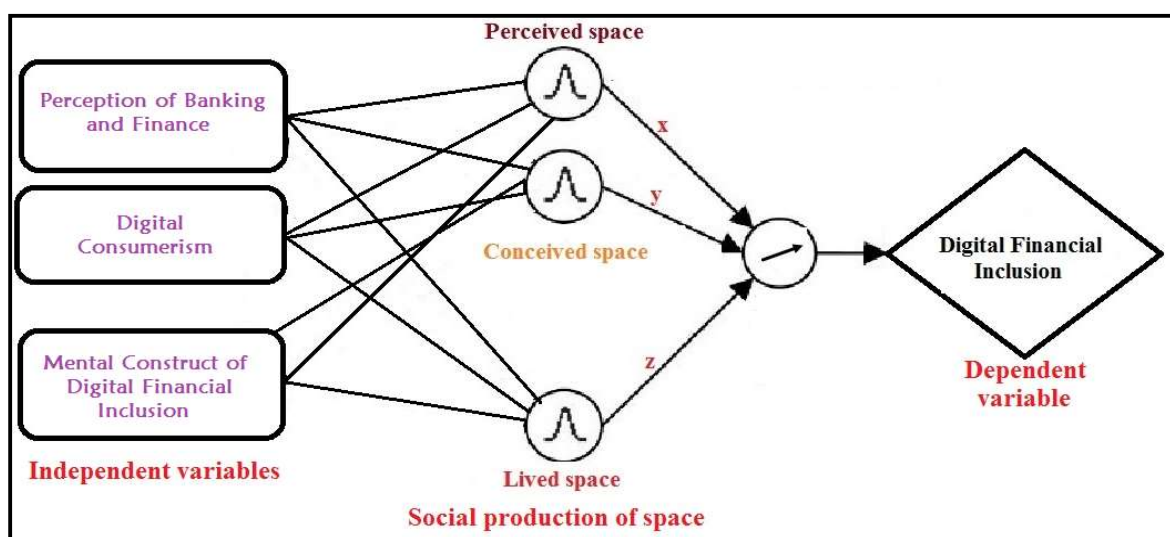


Figure 2: Conceptual framework for the social production of digital financial inclusion of Generation Z

Working around Figure 2, this paper explores how financial inclusion is socially constructed by Generation Z within the evolving digital banking ecosystem. The underlying hypothesis of this scientific inquiry is that there is a unique and objectively verifiable mental construct of financial inclusion that is significantly influenced by perception and digital consumer behaviourism. Francis and Hoefel (2018) underscore this assumption in asserting that this pragmatic and realistic construct of consumption coupled with technological advances is transforming the consumer landscape in a way that cuts across all socio-economic brackets and extends beyond Generation Z permeating the whole demographic pyramid. Given the growing digital consumer behaviourism across the human demographic pyramid, there is a need for new financial business models that embrace the dynamic consumption patterns in the digital financial space. This calls for deeper understanding of the intrinsic consumer behavioural characteristics, as well as the perceptions shaping the adoptive response to digital banking and finance. In this vein, the research considers the mental construct of digital financial inclusion as the social space that facilitates the socio-economic empowerment of Generation Z.

In view of the foregoing contextual, theoretical, and conceptual frameworks of this research, the purpose of this paper is to provide predictive insight for the development of inclusive digital banking ecosystems based on the mental construct of digital financial inclusion of Generation Z. This scientific endeavour is pursued across the Lefebvrian conceptual triad of social space thereby: 1) assessing the perception of Generation Z of the exclusivity of conventional banking and finance within the *Perceived space*; 2) exploring the nature of the digital consumer behaviourism of Generation Z within the *Conceived space*; and 3) predicting the mental construct of digital financial inclusion of Generation Z within the *Lived space*. The anticipated thesis on this topical subject matter is then presented in the concluding section of the paper, which is preceded by this introductory section, and the materials and methods, as well as the results and discussion.

2. MATERIALS AND METHODS

This scientific endeavour of understanding how financial inclusion in digital banking ecosystems is socially produced consists in firstly locating the study within a relevant philosophical research paradigm. Thus, a description of the Research design precedes descriptions of the methodological elements of study setting, sampling procedure, as well as the methods of data collection and data analysis. The chapter ends with the ethical considerations made during the research.

2.1 Research Approach and Design

The scientific disposition presented in the introductory section of this paper rests upon the epistemological stance of deductive logic, which is underpinned by the ontological assumption that reality is objectively understandable. Thus, the research fits within the Positivism worldview, which according to Guba and Lincoln (1994) consider experimentation, observation, or reason as the core tenets of the research paradigm. Fadhel (2002) notes that Positivism is used to search for cause and effect relationships in nature, and attempts to interpret observations in terms of facts or measurable entities, thereby providing explanations and predictions based on determinism, empiricism, parsimony, and generalizability. Under the overarching hypothesis that financial inclusion is socially produced in digital banking ecosystems, this research uses deductive logic to

study the contemporary subject within the Positivism philosophical worldview depicted in Figure 3.

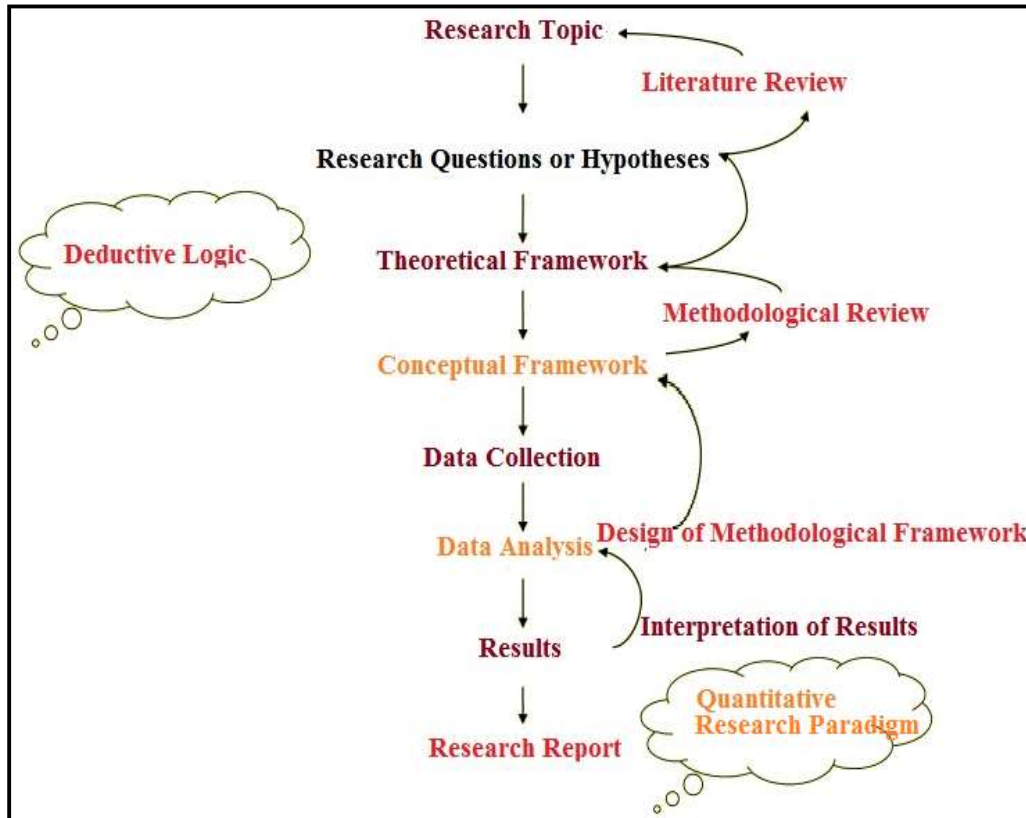


Figure 3: The Positivism philosophical worldview

Set within the Positivism philosophical worldview, this research employs a quantitative research paradigm to explore the nature of interactions between the components of a digital banking ecosystem. The choice of this approach is premised on the need to infer or predict the outcomes and patterns of the interactions of the socio-technical system that is gravitating towards financial inclusion. In this regard, the digital and financial consumer behaviourism of Generation Z and the emergence of digital financial technologies are identified as the key interactive elements of the digital banking ecosystem. Quantitative data about the proxy variables of the interactive elements is then collected and subsequently analysed numerically to answer the research questions. To this end, the methodological design framework includes the study setting, sampling procedure, data collection, and data analysis as described in the following sections.

2.2 Study Setting

The spatial setting of this research is Zambia, which is located in Southern Africa between latitudes 08° and 18° South of the Equator, and between longitudes 21° and 38° East of Greenwich Meridian. Zambia lies on the Central African high plateau covering a total area of 752,612 km² at an average altitude of 1200 m above sea level. This altitude influences a humid sub-tropical climate characterized by alternating hot-dry, rainy and cool-dry seasons with temperatures ranging from 19°C to 38°C, and rainfall varying from 600 mm to 1500 mm per annum. As can be seen in Figure

3, Zambia is a land-linked country that is bordered by eight countries including the Democratic Republic of Congo, Tanzania, Angola, Namibia, Malawi, Mozambique, Zimbabwe and Botswana.



Source: <http://www.cartedumonde.net>

Figure 4: Map of Zambia

The land-linked ecosystem of Zambia presents economic opportunities based mainly on mining, agriculture and intra-continental commerce. In this regard, the Zambian economy has historically been based on the copper-mining industry making the country to be one of the world's fastest growing economies for the ten years up to 2014, with real Gross Domestic Product (GDP) growth averaging roughly 6.7% per annum (CIA, 2019). However, Zambia's dependency on copper as its sole major export makes it vulnerable to fluctuations in the world commodities market (CIA, 2019). In an effort to reduce vulnerability of Zambia to the volatility of copper prices on the world market, there have been transitions of the Zambian economy towards diversification, particularly focusing on commercialization and industrialization of Zambia's agriculture. Agriculture is an important socio-economic sector for Zambia providing livelihood to over 60 percent of the population (ZDA, 2019) with a contribution to the country's GDP. With regards to commerce, Zambia lends itself as the epicentre of trade through the major regional groupings, namely the Southern Africa Development Community (SADC) and the Common Market for Eastern and Southern Africa (COMESA). These regional groupings accord the country opportunities for intra-continental commerce and financial sector development to facilitate the exchange of goods and services locally and internationally. Financial sector development in Zambia is particularly focused on improving efficiency and competitiveness of the sector and enhancing choices of

financial products and services towards an inclusive financial services delivery that enables an environment for economic growth and development (NFIS, 2019).

With the Zambian human population estimated at 18.3 million, and growing at 2.93% annual per annum (UN, 2019), Zambia's socio-economic landscape is characterized by significant human development challenges leading to widespread extreme rural poverty, high unemployment levels, and social inequality. The World Bank (2019) observes that Zambia ranks among the countries with highest levels of inequality globally whereby 58 % of its population earn less than the international poverty line of \$1.90 per day compared to 41% across Sub-Saharan Africa, with 75 % of the population living in rural areas. Based on the current population growth rate, the Zambian population is projected to be 40 million by 2050 with a notable demographic boom of young people. These demographic trends and the pervasive human development challenges underscore the drive towards sustainable development to which Zambia has subscribed with the rest of the international community to leave no one behind. Within the sustainable development paradigm, the evolving Digital Financial Services (DFS) promise to enhance social equity through financial inclusion of the most vulnerable populations to extreme poverty. The DFS market is expanding with significant growth in the number of active customers, agents and DFS providers.

In Zambia, as is the experience of many other countries in sub-Saharan Africa and the developing economies, the DFS industry has been growing from having 2 % of the adult population with an active DFS account in 2014 to 18% in 2016 and 24 % in 2017 serviced by 18 DFS providers (Harihareswara *et. al.*, 2018). The UNCDF (2019) further reports that there are at least 25 Financial Technology (FinTech) companies in Zambia developing solutions across various sectors ranging from financial services to education, agriculture and health. In light of these developments, Zambia envisions universal access to and usage of a broad range of quality and affordable financial products and services and as such is implementing a National Financial Inclusion Strategy [NFIS] (2017) with a target of an overall increase in formal financial inclusion in Zambia from 38 % in 2017 to 70 % by 2022. By this strategy, it is expected that all Zambians will reap the full benefits of financial inclusion in that individuals will be able to use appropriate savings, credit, payment, insurance and investment services to manage risks, plan for the future and achieve their goal; while firms will be able to access affordable financing to facilitate innovation and firm growth and create employment.

Despite the progressive experience of financial inclusion in Zambia via digital financial services whereby 4.8 million adults (59.3 % of the adult population) were financially included as of 2015, there remains more than 3.5 million Zambian adults (approximately 41 % of the adult population) that are financially excluded and more than 5 million Zambian adults (approximately 60 % of the adult population) that do not use financial products and services from regulated providers (NFIS, 2017). Against this backdrop, the potential to leverage digital technologies to reduce costs and expand the reach of the formal financial sector has not yet been fully exploited and as such non-bank financial institutions such as insurance companies, pension providers, and microfinance institutions have limited outreach (NFIS, 2017). Digital technologies such as cloud computing, smartphones and high-speed Internet are definitely creating smart pathways to digital financial transformation for inclusive participation of the excluded segments of the society. The application of digital technologies to finance (Arner *et. al.*, 2016) is set to engender a new era of digital finance

around the world that extends from the application of artificial intelligence and machine learning to big data and from the use of biometric identification to block chain technology (AFI, 2018).

2.3 Sample Population and Size

The target population of interest to this research is herein defined as young people belonging to Generation Z that is drawn from a relatively large population in the Central Business Districts of Zambia. This target group is deemed to be actively using financial technologies to access the available digital financial services. In this regard, the sampling frame for the research consists of the digital financial services facilities, particularly the mobile digital banking service provided by the Zambia National Commercial (ZANACO) Bank. ZANACO's mobile banking service is spread across the country involving over 5,000 agents. Thus, the unit upon which the probability of selection of respondents of the research is based is the individual belonging to Generation Z that is accessing the ZANACO mobile digital banking service.

The specific focus of the research on Generation Z dictates the use of the purposive sampling method, which is a form of non-probability sampling by which all participants of a study are selected because they fit a particular profile. This method is associated with several benefits. In the main, purposive sampling enables researchers to gather a lot of information from the data collected thereby enabling researchers to gain as much insight from as many angles as possible so that they can describe the major impact of their findings on the population. However, the major limitation of purposive sampling is its dependency on the judgement of the researcher in selecting the sample. This may introduce bias if the researcher's judgement is poor. In the context of this research, the target population of Generation Z is well defined on the basis of the verifiable age description, and is homogeneously characterised by the ability to use digital technologies to access financial services.

In consideration of the relatively large sample population of the study as described earlier, the sample size for the study is determined as 360. This is estimated at the confidence level of 95% and a response rate of 80 % as determined using Cochran's sample size formula in Equation 1; where, z is the Standard normal probability score; ε is the margin of error; and \hat{p} is the population proportion. This formula is widely used to determine the appropriate sample size for the proportion of the study population that possesses a particular property.

$$n = \frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2} \quad [1]$$

2.4 Data Collection

Based on the conceptual framework presented in the introductory section of this paper, the research dictates the use of a quantitative research instrument. As such a questionnaire was structured in such a manner as to collect primary data from the respondents constituting the sample for the research. The questionnaire was designed to capture categorical data about the perception of banking and finance; digital consumer behaviourism; and digital financial inclusion of Generation Z. The parameters and proxy variables are listed in Table 1.

Table 1: Data profile for the research on social production of digital financial inclusion

Parameters	Proxy variables
1) Perception of Generation Z of the conventional banking and finance (<i>Perceived space</i>)	<ul style="list-style-type: none"> ○ Age ○ Gender ○ Education Level ○ Employment status ○ Exclusivity of banking and finance
2) Digital consumer behaviourism of Generation Z (<i>Conceived space</i>)	<ul style="list-style-type: none"> ○ Propensity to use digital technologies ○ Digital competence ○ Social media networking
3) Digital financial inclusion of Generation Z (<i>Lived space</i>)	<ul style="list-style-type: none"> ○ Access to credit facilities ○ Access to electronic payment platforms ○ Access to mobile money networks ○ Start-up business innovation programmes

The data collection protocol consisted in administering questionnaires to 360 respondents, purposively selected from the Zambian urban communities of Lusaka and Copperbelt. These urban communities are densely populated, and have a high intensity of socio-economic activity for which digital financial technology plays a significant role of facilitating quick access to financial products and services.

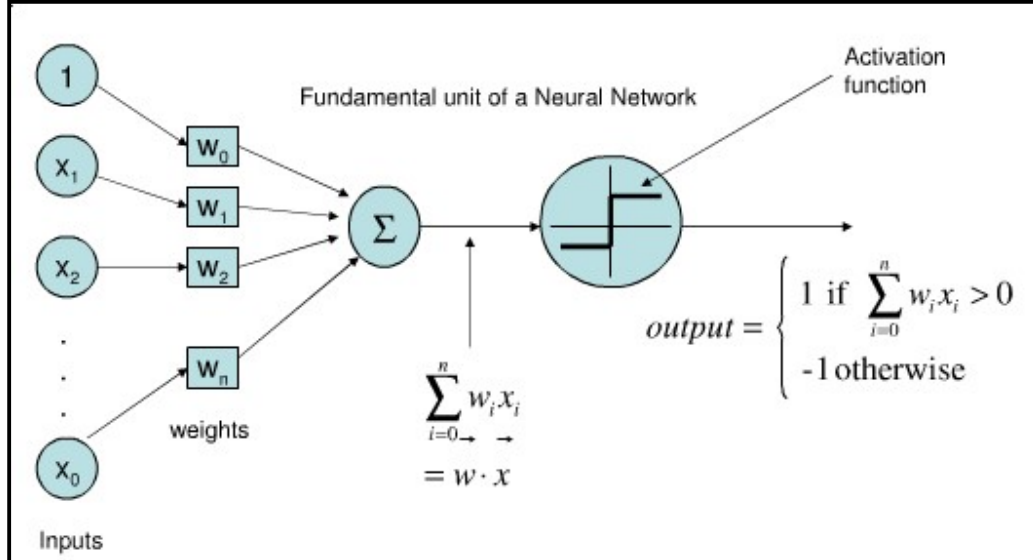
2.5 Data Analysis

With due diligence to the purpose of the article highlighted in the introductory section of this paper, the study applies predictive modelling and multivariate statistical techniques to model the digital financial inclusion of Generation Z based on the Lefebvorean conceptual triad of perceived space, conceived space and lived space. Thus, the analytical framework specifically employs an *artificial neural network* to model the perception of Generation Z of the exclusivity of conventional banking and finance within the *Perceived space*. Thereupon, *Principal component analysis* is used to explore the nature of the digital consumer behaviourism of Generation Z within the *Conceived space*; and then *Structural equation modelling* is used to predict digital financial inclusion of Generation Z based within the *Lived space*. Concise mathematical descriptions of these analytical methods are presented in Sub-sections 2.5.1, 2.5.2 and 2.5.3.

2.5.1 Predictive Modelling with Artificial Neural Network

Artificial neural network (ANN) is a computational model that is inspired by a biological neuron, which is a fundamental unit of the brain and nervous system with cells that receive sensory input from the external world via dendrites, and process it to generate the output through axons (Chauhan, 2019). As a deep learning technology of the digital age, an ANN learns to perform classification tasks to solve complex problems underlain by non-linear processes. As such an ANN is composed of a large number of highly inter-connected neurons working in unison to solve a specific problem by receiving inputs and delivering outputs based on predefined activation

functions (Chauhan, 2019). The fundamental unit of an ANN is called a *Perceptron* which is a mathematical function conceived as a model of a biological neuron (See Figure 5).



Source: <https://i.stack.imgur.com/KUvpQ.png>

Figure 5: Structure of a perceptron in an artificial neural network

As seen in Figure 5, the perceptron computes a single output from multiple real-valued inputs (X_n) by forming a linear combination according to its input weights (W_n) and then possibly putting the output through some nonlinear activation function. Mathematically, this can be expressed by Equation 2, where \mathbf{W} denotes the vector of weights, \mathbf{X} is the vector of inputs, b is the bias and ϕ is the activation function.

$$y = \phi\left(\sum_{i=1}^n w_i x_i + b\right) = \phi(\mathbf{w}^T \mathbf{x} + b) \quad [2]$$

Perceptrons can be used as building blocks of larger neural structures such as the Multilayer perceptron (MLP) that have more predictive power. A typical multilayer perceptron network consists of a set of source nodes forming the input layer, one or more hidden layers of computation nodes, and an output layer of nodes. The input signal propagates through the network layer-by-layer. The computations performed by such a feedforward network with a single hidden layer with nonlinear activation functions and a linear output layer can be expressed mathematically by Equation 3, where \mathbf{S} is a vector of inputs and \mathbf{X} is a vector of outputs.; \mathbf{A} is the matrix of weights of the first layer; \mathbf{a} is the bias vector of the first layer; \mathbf{B} and \mathbf{b} are, respectively, the weight matrix and the bias vector of the second layer. The function ϕ denotes an elementwise nonlinearity.

$$\mathbf{x} = \mathbf{f}(\mathbf{s}) = \mathbf{B}\phi(\mathbf{A}\mathbf{s} + \mathbf{a}) + \mathbf{b} \quad [3]$$

MLP networks are typically used in supervised learning problems. This means that there is a training set of input-output pairs $[\mathbf{S}(t), \mathbf{X}(t)]$ and the network must learn to model the dependency

between them. The training involves adapting all the weights and biases to their optimal values for the given pairs. The criterion to be optimised is typically the squared reconstruction error given by Equation 4.

$$\sum_t ||\mathbf{f}(\mathbf{s}(t)) - \mathbf{x}(t)||^2 \quad [4]$$

2.5.2 Principal Component Analysis

Principal Component Analysis (PCA) proposed by Hotelling (1933) is one of the most common methods of multivariate analysis used to analyse interrelationships among a large number of variables. The main objective of PCA is to reduce the number of variables and to cluster them into more parsimonious and manageable groups, the goals being simplification, data reduction, modelling, outlier detection, variable selection, classification, and prediction. The mathematical basis for PCA is that it is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called “principal components” (Jolliffe, 2002). This transformation is defined in such a way that the first principal component has the largest possible variance, and each succeeding component in turn has the highest variance possible under the constraint that it is orthogonal to the preceding components. The methodical determination of the principal components from a raw dataset can be simplified into a five-step process based on principles of mathematical linear algebra and statistics.

The first step involves standardising the variables. The aim of standardisation is to transform a variable to one with a mean of 0 and a standard deviation of 1 so that each of a given range of the continuous initial variables contributes equally to the analysis. Mathematically, this is given by Equation 5, where z is the standardised variable; x is the random variable; μ is the mean; and σ is the standard deviation.

$$z = \frac{x - \mu}{\sigma} \quad [5]$$

The second step involves computation of the Covariance matrix in order to understand how the variables of the input data set are varying from the mean with respect to each other, or to see if there is any relationship between them. The Covariance matrix for a 2-dimensional dataset with X and Y variables, for example, is given by Equation 6, where $cov(X, Y)$ is the covariance of two variables ‘ X ’ and ‘ Y ’; n is the number of samples in a dataset; $(N-1)$ is the number of observations that are free to vary when estimating the parameters; and μ is the mean of the random variable.

$$cov(X, Y) = \frac{\sum_{i=1}^n (x_i - \mu_x)(y_i - \mu_y)}{(n - 1)} \quad [6]$$

Equation 3 yields a symmetric matrix of the dimensions in a dataset with entries associated with all possible pairs of the initial variables. The sign of the covariance is an important indicator of the nature of the relationship between variables. The positive sign indicates that the variables are directly correlated, while a negative sign indicates that the variables are inversely related.

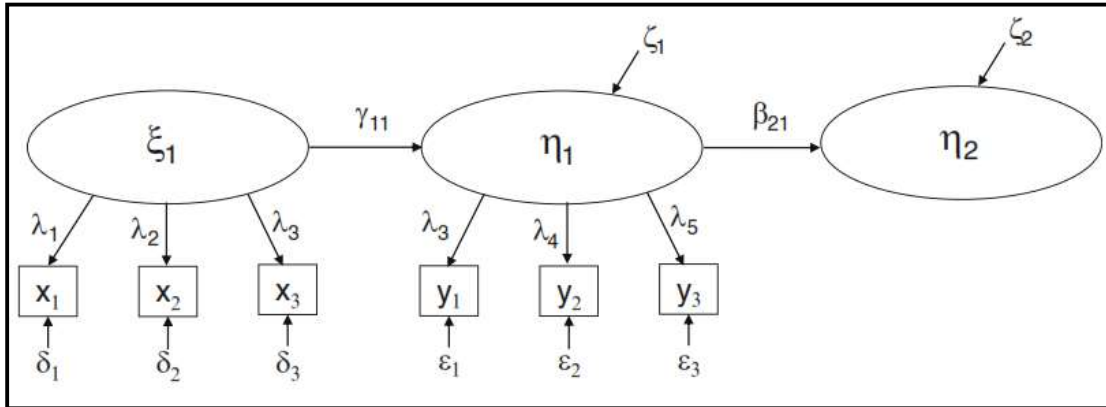
The third step of PCA is to compute the eigenvectors and eigenvalues of the covariance matrix in order to identify the principal components. An eigenvector is defined as a vector whose direction remains unchanged when a linear transformation is applied to it, and each eigenvector has a value so referred to as an eigenvalue. The eigenvectors of the Covariance matrix are actually the directions of the axes where there is the most variance and are as such called the Principal components, and the eigenvalues are simply the coefficients attached to eigenvectors, which give the amount of variance carried in each principal component. In mathematical linear algebra, the eigenvalue problem typically considers the vector equation given by Equation 7, where A is an $n \times n$ matrix; x is a non-zero vector of the matrix A ; and λ is the eigenvalue of the eigenvector x .

$$Ax = \lambda x \quad [7]$$

Having computed the eigenvectors and eigenvalues of the covariance matrix to determine principal components, the fourth step of PCA is arranging the principal components in order of significance in accounting for the variance in the dataset. This means selecting the vectors with the highest eigenvalues and discarding those with low eigenvalues. The remainder form a matrix of eigenvectors called a “Feature vector”. The last step of the PCA is to recast the data along the principal components axes the aim of which is to use the feature vector formed using the eigenvectors of the covariance matrix to re-orient the data from the original axes to the ones represented by the principal components. In mathematical terms, this can be done by multiplying the transpose of the original data set by the transpose of the feature vector.

2.5.3 Structural Equation Modelling

Structural equation modelling (SEM) is a multivariate statistical framework that is used to model complex relationships between directly observed and indirectly observed or latent variables (Stein *et.al.* 2017). SEM particularly estimates a system of linear equations to test the fit of a hypothesized “causal relationship” model, which is visually presented as a “*path diagram*” based on prior knowledge and/or theories (Stein *et.al.* 2017). As illustrated in Figure 6, path diagrams are constructed with rectangles representing observed or directly measured variables, and circles or ovals representing unobserved or latent constructs that are defined by measured variables. Unidirectional arrows then represent causal paths, where one variable influences another directly, and double-headed arrows represent correlations between variables.



Source: (Stein *et.al.* 2017).

Figure 6: Path diagram in Structural equation modelling

The path diagram in SEM visualizes two sub-models using a system of linear equations. The first model is the *Measurement model* that estimates relationships between the observed variables or indicators, and latent variables. Thus, using the path diagram in Figure 6, the Measurement model is given by Equation 8; where, the x and y symbols are observed indicators for latent variables, the ξ and η symbols are latent variables, the λ symbols are factor loadings, and the ε and δ symbols are the error, or disturbance terms.

$$\begin{aligned} x_1 &= \lambda_1 \xi_1 + \delta_1 & y_1 &= \lambda_3 \eta_1 + \varepsilon_1 \\ x_2 &= \lambda_2 \xi_2 + \delta_2 & y_2 &= \lambda_4 \eta_1 + \varepsilon_2 \\ x_3 &= \lambda_3 \xi_3 + \delta_3 & y_3 &= \lambda_5 \eta_1 + \varepsilon_3 \end{aligned} \quad [8]$$

The second model in SEM is the *Structural model* that develops the relationships between the latent variables based on the endogenous and exogenous variables. The structural model is then described by Equation 9; where, the γ and β terms are factor loadings for the latent variables, and ξ and ζ are error terms. The structural model can then evaluate potential causal relationships between the endogenous and exogenous variables.

$$\begin{aligned} \eta_1 &= \gamma_{11} \xi_1 + \zeta_1 \\ \eta_2 &= \beta_{21} \xi_2 + \zeta_2 \end{aligned} \quad [9]$$

The systems of equations in SEM are fitted to the data using the Maximum likelihood estimation fitting functions assuming that the data are normally distributed and the observations are independent. Hancock (2003) notes that the use of SEM is commonly justified in the social sciences because of its ability to impute relationships between unobserved constructs (latent variables) from observable variables.

3. RESULTS AND DISCUSSION

This section presents the scientific evidence of how digital financial inclusion is socially produced in digital banking ecosystems under the socio-economic context of Zambia in sub-Saharan Africa. The chapter is organised into two sub-sections, the first of which is a concise presentation of the results of the scientific investigation. This is then followed by a discussion of the results within the framework of the Lefebvorean conceptual triad of social space. The discussion particularly provides predictive insight for the development of inclusive digital banking ecosystems based on the mental construct of digital financial inclusion by Generation Z.

3.1 Results

3.1.1 Perception of Generation Z of Conventional Banking and Finance

The first step towards understanding how digital financial inclusion of Generation Z was socially produced was testing the proposition that conventional banking and finance was exclusive to Generation Z. An ANN model was built with the Multi-layer perceptron in the Statistical Package for Social Sciences (SPSS Version 21) to test the proposition using the socio-demographics of Generation Z as the predictor variables. The resultant network diagram is given in Figure 7.

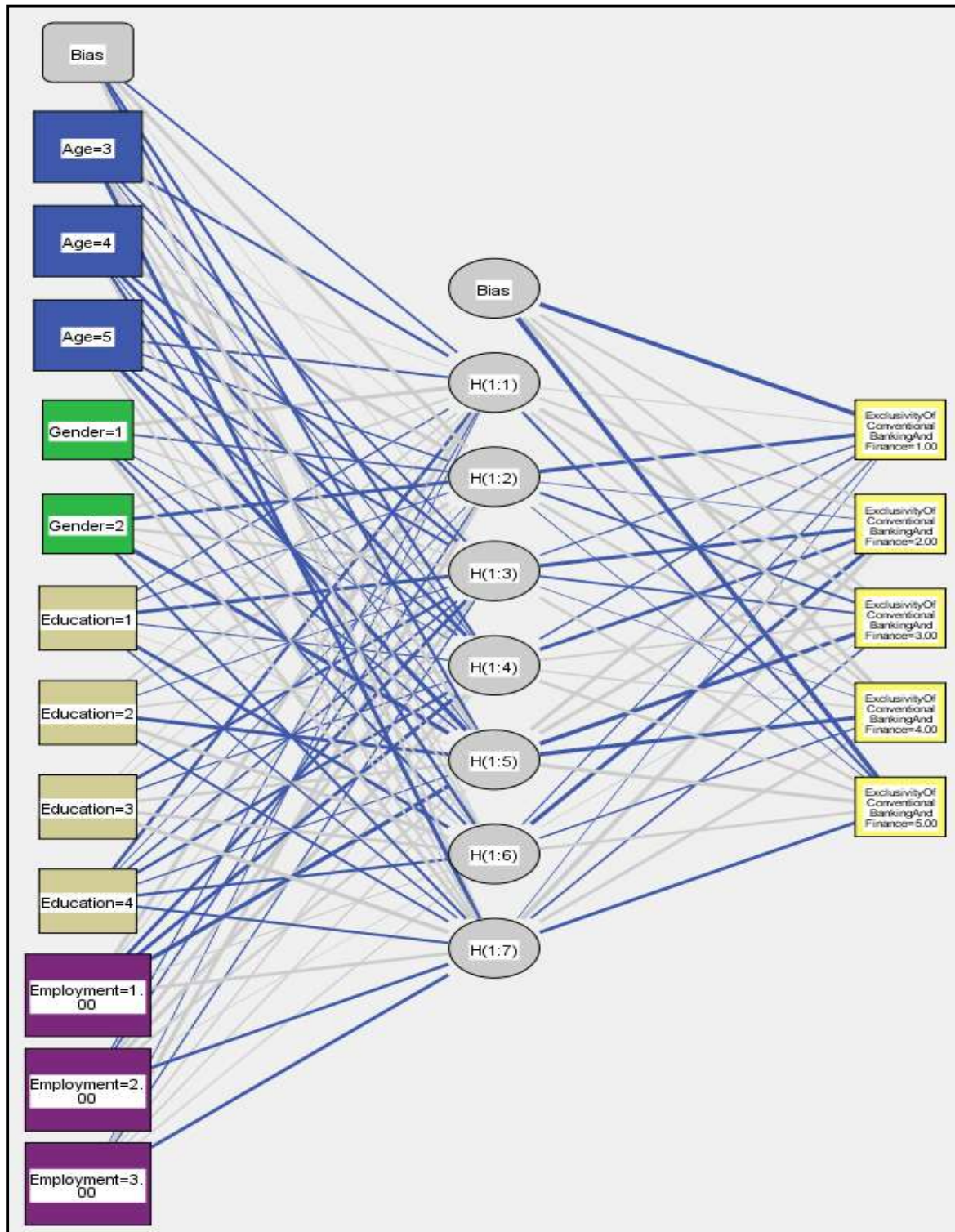


Figure 7: Multi-layer perceptron neural network for predictive modelling of perception of Generation Z of the exclusivity of conventional banking and finance.

The network descriptors consist of the input layer with 12 units of the predictor variables including age, gender, education level, and employment status of Generation Z; one hidden layer with 7 units and the hyperbolic tangent as an activation function; and one output layer with 5 units of the dependent variable being the exclusivity of conventional banking and finance. The activation function for the output layer was the normalised exponential function called “Softmax”, which was used as a multiclass classification method under the cross-entropy regime summarised in Table 2.

Table 2: Cross-entropy regime of predictive modelling with the MLP neural network

Model summary	
Training	Cross Entropy Error 280.338
	Percent Incorrect 48.8%
	Predictions
	Stopping Rule Used 1 consecutive step(s) with no decrease in error
Testing	Training Time 0:00:00.25
	Cross Entropy Error 84.163
	Percent Incorrect 34.4%
	Predictions

As can be observed from Table 2, the neural network was 65.6 % correct in making the prediction based on the cross-entropy error function. Thus, the model predicted with reasonable accuracy that 97.9 % of the respondents perceived conventional banking and finance as exclusive (See Table 3).

Table 3: Perception of Generation Z of the exclusivity of conventional banking and finance

Sample	Observed	Predicted					
		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree	Percent Correct
Training	Strongly Disagree	0	0	0	2	0	0.0%
	Disagree	0	5	0	58	0	7.9%
	Not Sure	0	0	0	59	0	0.0%
	Agree	0	0	0	124	0	100.0%
	Strongly Agree	0	0	0	4	0	0.0%
	Overall Percent	0.0%	2.0%	0.0%	98.0%	0.0%	51.2%
Testing	Strongly Disagree	0	0	0	0	0	0.0%
	Disagree	0	2	0	14	0	12.5%
	Not Sure	0	0	0	18	0	0.0%
	Agree	0	0	0	61	0	100.0%
	Strongly Agree	0	0	0	1	0	0.0%
	Overall Percent	0.0%	2.1%	0.0%	97.9%	0.0%	65.6%

Decomposition of the socio-demographic variables used to model the perception of the exclusivity of conventional banking and finance showed that employment status was the most important factor

with a normalised importance of 0.351 as shown in Figure 8. The second most important variable was age, which had the normalised importance value of 0.264 ahead of education (0.21) and gender (0.17). In statistics, importance sampling is a general technique for estimating properties of a particular distribution, while only having samples generated from a different distribution than the distribution of interest. In practical terms, importance sampling evaluates the values of the input random variables in a simulation for relative impact on the parameter being estimated.

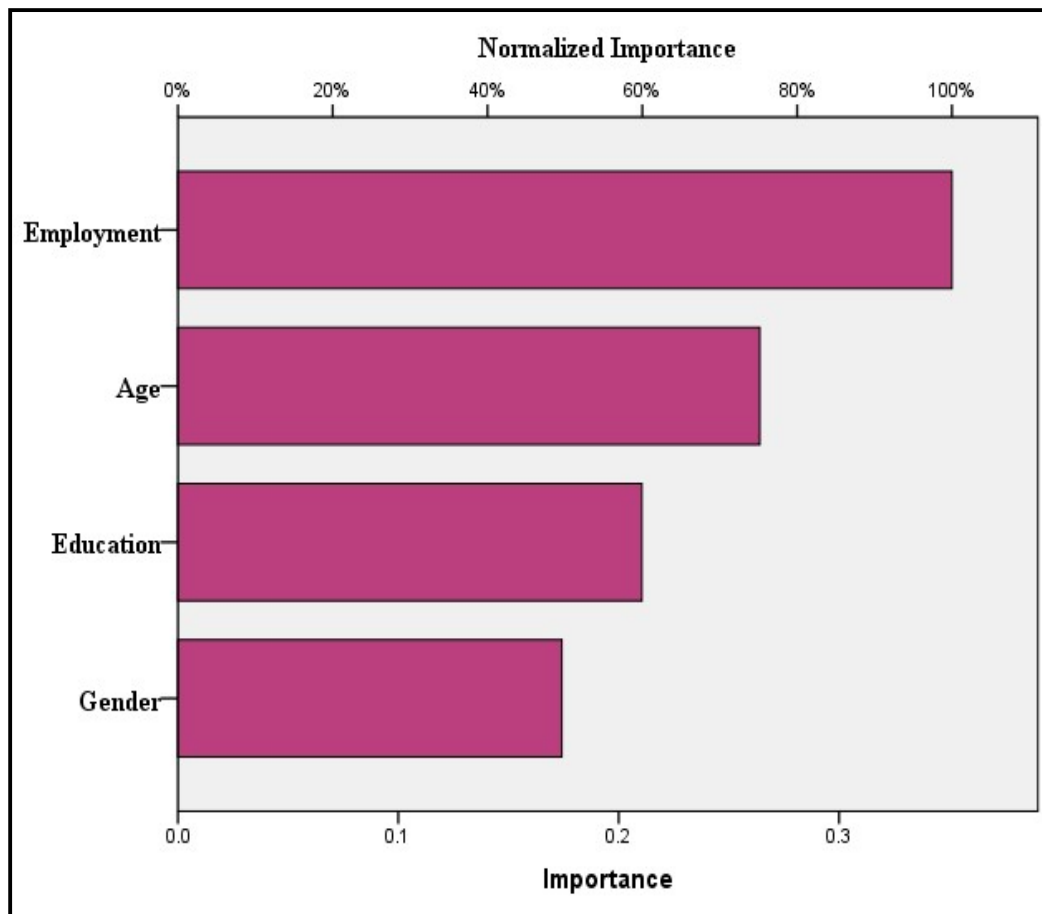


Figure 8: Normalised importance of the response variables

3.1.2 Principal Components of the Digital Consumer behaviourism of Generation Z

Further to the assessment of the perception of Generation Z of the exclusivity of conventional banking and finance, factor analysis of the digital consumer behaviourism of Generation Z was performed to identify the principal components for the conceived space in the social production of digital financial inclusion. The selected variables for the analysis included the propensity to use digital technologies, digital competence, and social media networking. These variables were subjected to factor analysis in SPSS using the PCA extraction method in order to extract the variance accounted for by each of the composite variables. The analysis as presented in Table 4

demonstrates that the propensity to use digital technologies as well as digital competence account for nearly 70 % of the total variance, with social media networking accounting for the remaining 30 %.

Table 4: Principal components of the digital consumer behaviourism of Generation Z

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.104	36.798	36.798	1.104	36.798	36.798
2	1.003	33.434	70.232	1.003	33.434	70.232
3	0.893	29.768	100.000			

3.1.3 Digital Financial Inclusion of Generation Z

In all its complexity, the digital financial inclusion of Generation Z was befittingly modelled using the multivariate statistical technique of Structural equation modelling. The structural equation model was constructed with the need for digital financial inclusion as the endogenous variable, while perception of conventional banking and finance, propensity to use digital technologies, and mental construct of digital financial inclusion constituted the exogenous variables. The resultant path diagram of the structural equation modelling was generated to show the standardised estimates of the causal relationships as represented in Figure 9.

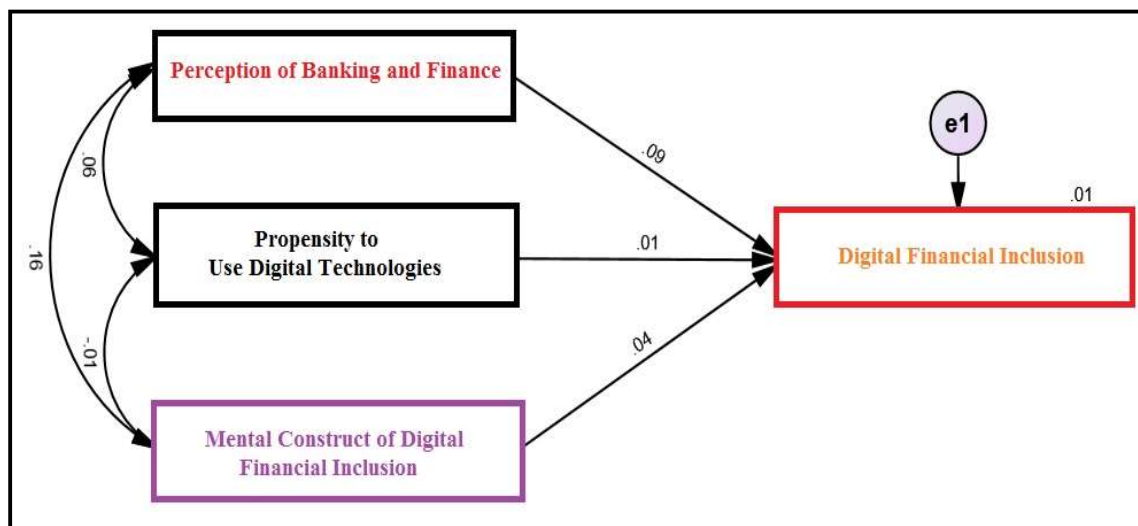


Figure 9: Path diagram for the mental construction of digital financial inclusion of Generation Z

The path diagram in Figure 9 demonstrates that the digital financial inclusion of Generation Z is highly influenced by the perception of Generation Z of the exclusivity of conventional banking and finance. This is based on the resultant standardised coefficient of 0.09, which is twice the coefficient for the mental construct of digital financial inclusion, and nine times the coefficient for the propensity to use digital technologies. However, one salient feature of the results is that all the

exogenous variables as well as the unobserved variables were all statistically significant in predicting the endogenous variable. Table 5 shows a p-value of 0.001 for all the variables. However, the mental construct of digital financial inclusion has the highest direct effect (1.883) on the dependent variable.

Table 5: Statistical significance of the exogenous and unobserved variables

Parameters	Estimate	S.E.	C.R.	P-value
1) Perception of banking and finance	0.755	0.056	13.398	0.001
2) Propensity to use digital technologies	0.030	0.002	13.398	0.001
3) Mental construct of digital financial inclusion	1.883	0.141	13.398	0.001
4) Unobserved, ϵ_1	0.330	0.025	13.398	0.001

Another important result of the data analysis is of the two-tailed test of significance (See Table 6), which showed that the mental construct of digital financial inclusion had the most direct effect on the need for digital financial inclusion of Generation Z as compared to the perception of banking and finance, and the propensity to use digital technologies.

Table 6: Two-tailed test of significance of the standardized direct effects

	Mental construct of digital financial inclusion	Propensity to use digital technologies	Perception of Banking and Finance
Digital financial inclusion	0.365	0.051	0.166

3.2 Discussion

Dwelling upon the Lefebvorean theory of Social Production of Space, this present study of financial inclusion of Generation Z in digital banking ecosystems firstly tested the proposition that conventional banking and finance was exclusive in the perceived space. The Multilayer perceptron neural network predicted that the proposition was true when analysed across the socio-demographic profile of Generation Z to the effect that employment status had the most direct influence on the highly perceived exclusivity. This is conceivable under a typical socio-economic setting of sub-Saharan Africa in which the demographic pyramid is underlain by a high population of young people including Generation Z who are mostly unemployed. In Zambia, youth unemployment is pervasively unprecedented, and official government reports indicate that on average only about 6 % of the 120,000 young people that graduate from high school are admitted into colleges and universities. This implies that 94 % of the high school leavers immediately graduate into the informal economy to build up the population of the unemployed youth that did not even complete high school. Yet still, only a small proportion of graduates from colleges and universities who have attained higher education and training are absorbed into the formal job market. In this conundrum of youth unemployment in Zambia, the financial circumstances and

needs of Generation Z are a definite misfit in the regulatory framework of banking and finance. Therefore, banking and finance appears to be exclusive. The highly perceived exclusivity of conventional banking and finance is not unique to Generation Z or the youth in general. Even the low-income adult population in the working class hold a similar view in so far as it does not meet the eligibility requirements for access to financial products and services.

Lefebvre's philosophy can then contribute to critical thinking about the exclusivity of banking and finance in the perceived space. Central to Lefebvre's philosophy is the idea that everyday life forms representational spaces distinguished as dominated and appropriated spaces (Lefebvre, 1991). In Lefebvre's view, commodities are produced, exchanged, and consumed, which results in special spaces for their production, exchange and consumption at the centres of commerce in the economic space, which Lefebvre sees as the capitalist form of dominated space that tends to crush the lived spaces of everyday life. Lefebvre (1991) postulates that capitalism and neo-capitalism have produced such abstract spaces as of the world of commodities, its logic and worldwide strategies founded on the vast network of banks, business centres and major productive entities. Lefebvre then argues that there is a possibility of a dominant space organizing and instrumentalizing social space in its interest to achieve advantages at the expense of other groups. From this Lefebvorean perspective, it can be seen that the ostensive exclusivity of conventional banking and finance as observed at the frontier of a mobile money network in Zambia is a syndrome of the dialectical tensions that are overlooked in the regulatory framework of banking and finance. The unintended outcome of the exclusionary regulations and procedures of conventional banking and finance is then reciprocity of the excluded in the conceived and lived spaces.

The reciprocal action of those who feel excluded from conventional banking and finance is the adoptive response to the promise of financial inclusion in the emergence of micro-finance and savings clubs along with financial technologies. Micro-financial institutions and savings clubs have remarkably eroded conventional banking and finance with unprecedented financial inclusion of the misfits of the strict regulatory framework of commercial banks. To this end, the emergence of financial technologies has not only accorded easy access to financial products and services, but also provided employment opportunities to the digitally competent youth, mostly of Generation Z. Thus, in the second part of this present study, Principal component analysis showed that Generation Z had high propensity and competence to use digital technologies as well as belong to social media networks. The implication of this finding for the conceived space of the digital banking ecosystem is that direct marketing of financial products and services via digital platforms is critical to financial inclusion of Generation Z. This is self-evident in the wake of the global pandemic of COVID-19 that has fuelled the demand for digital financial services worldwide.

The socio-technical system revolving around digital finance is now a contested space between the forerunners of micro-finance and the lethargic commercial banks that are caught up in a rigidity trap. In Zambia, a few commercial banks such as the Zambia National Commercial Bank (ZANACO) have condescended to participate in mobile money service delivery and micro-finance as part of institutional innovation, of course with an ostentatious huge economy of scale. Embracing the Lefebvorean philosophy in this line of argument, it can be prognosed that the dominant financial sector players have a tendency to globalize the economic space in order to make use of strategic advantages for capital accumulation. To that effect, Lefebvre postulates that "Capitalism fragments space and interconnects the fragments at the regional, national,

international, and global levels thereby advancing dominant interests and transforming social spaces and instrumentalizing them as means of control, power and capital accumulation". It appears then that conventional banking and finance operates along a continuum between social equity and financial sustainability, posing a conceptual challenge of designing financial business models that are equitable without undermining the sustainability of the financial ecosystem.

From the foregoing dialectical tension between the perceived space and the conceived space in the prospective design of inclusive financial business models, the notion of participatory accountability stands out as a plausible solution to the perceived problem of financial exclusion. Participate (2020), which is a global network of participatory research organisations, intimates that participatory accountability is necessary for the realities of the marginalised to be understood, and for their voices to be heard through processes that enable personal empowerment. In the lived space of Generation Z, therefore, participatory accountability in digital banking ecosystems could then be decoded from the result of the Structural equation modelling of digital financial inclusion. The model predicted that digital financial inclusion was directly influenced by the mental constructs of digital financial inclusion including enhanced access to credit facilities, electronic payment platforms, mobile money networks, and start-up business innovation programmes. An intra-model meta-analysis of these mental constructs indicated that start-up business innovation programmes was the most preferred means of participation of Generation Z in the digital banking ecosystem. This could be linked to the pervasive unemployment status of the youth that correlated highly with the exclusivity of conventional banking and finance in the perceived space.

Participatory accountability as a precursor to financial inclusion is in itself an elusive concept that must be thoughtfully applied to the design of inclusive financial business models. Lefebvre's insights are, therefore, critical to understanding the way in which digital financial inclusion may be socially produced. There stands a possibility of overly estimating the mental constructs of the digital financial inclusion of Generation Z with the predictive modelling in this study. At the same time, the latent effects of neo-capitalism on digital consumer behaviourism and financial technology have not been explored to reveal the inherent complexities in the evolving socio-technical system. In certain instances, for example, digital consumer behaviourism in the use of information technology has been deemed to be dangerous enthusiasm (Stewart & Andy, 2009). The intellectual tendency of this study to theorise the social production of financial inclusion of Generation Z based on participatory accountability then succumbs to the illusion of transparency in the biased estimation of understanding the mental constructs of the digital financial inclusion of Generation Z. Meta-analysis of the findings of this research is hereby recommended to address the complexities in the social production of financial inclusion in digital banking ecosystems, albeit the limited availability of such studies in scientific literature. Therefore, the discussion of the findings of this research concludes with a hypothesis that digital financial inclusion of Generation Z in digital banking ecosystems is an outcome of the co-evolutionary dynamics of digital consumer behaviourism and financial technology.

4. CONCLUSION

The scientific endeavour of understanding how financial inclusion of Generation Z in digital banking ecosystems is socially produced has been achieved with predictive modelling of the perception, digital consumer behaviourism and mental constructs of digital financial inclusion of

Generation Z using Artificial neural network analysis, Principal component analysis, and Structural equation modelling respectively. To this end, this article has shown that Generation Z has a high propensity and competence to use digital devices, social media, and financial technologies, but perceives conventional banking and finance as highly exclusive. Using the Lefebvorean theory of Social Production of Space to critically reflect on the topical issue of financial inclusion, the paper contributes an understanding that the conventional banking ecosystem operates along a continuum between social equity and financial sustainability, posing a conceptual challenge of designing financial business models that are equitable without undermining the sustainability of the banking ecosystem. As such the notion of participatory accountability has been advanced as a pathway to designing authentically inclusive financial business models that embrace the mental constructs of Generation Z for financial inclusion, notably increased access to start-up business innovation programmes. However, further research is recommended to reveal the co-evolutionary dynamics of financial technology and digital consumer behaviourism as the socio-technical system gravitates towards the digital financial inclusion of Generation Z.

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